

Non-industrial Timberland Management Plan

GROWTH AND YIELD GUIDELINES

By

Department of Forestry and Fire Protection

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Workshops

In response to public concern over the high number of Non-industrial Timberland Management plan (NTMP) returned as unacceptable for filing by the California Department of Forestry and Fire Protection (CDF, Department), the Department held a series of workshops in 2004 with registered professional foresters (RPFs) and landowners¹. Even though the workshop participants raised many issues, the majority of the discussion centered on the subject of growth and yield information provided in plans as a demonstration of maximum sustained production of high quality timber products (MSP). CDF has prepared a summary of all the concerns raised during the workshops. The summary and other documents pertaining to the workshops are posted at the Forest Practice Publications and Memorandums webpage (http://www.fire.ca.gov/php/rsrc-mgt_forestpractice_pubsmemos.php.)

The Department recognizes that many other issues in addition to growth and yield in NTMPs are of concern to attendees at the workshop. However, since so much time was expended in discussion of growth and yield, the Department has prepared this guidance document to assist consulting foresters, landowners and CDF staff in addressing this complex subject matter.

Addressing Growth and Yield in NTMPs

Introduction

Neither the Forest Practice Act (Act) nor the Forest Practice Rules (Rules) provide a prescriptive approach to the informational requirements required to assess growth and yield in NTMPs. This analysis falls within the area of expertise of a “professional forester” as defined under PRC § 752, and the definition of “forestry” as defined in PRC § 753. Thus, the Department expects this analysis will be completed by a qualified professional.

Given the general performance-based approach of the Rules, the Department expects that the RPF will demonstrate conformance to the Rules consistent with generally accepted approaches to growth and yield analysis. The plan should contain sufficient information for the Department to determine that the NTMP conforms to the Rules and Act per guidance provided in 14 CCR §

¹ See Appendix I for information about NTMP submissions, return rates, reasons for return, etc.

897(d) relative to application of judgmental terms. In reviewing the information provided, 14 CCR § 897(d) should guide the Department, and requests for additional information should be consistent with 14 CCR § 1037.5(g)(3). Where definitional issues arise, the Department will look to conventional sources such as the Society of American Foresters' dictionary², the Handbook of Forestry³ or other appropriate professionally accepted sources. Furthermore, where issues arise respective to forest management principles, the Department will rely on various forestry texts from the applied disciplines. Additional information relative to growth and yield review may be found in Appendix II— "*CDF Review Guidelines for CDF Review Team Staff Evaluating for Maximum Sustained Production in Nonindustrial Timber Management Plans (NTMPs)*."

CDF's review of growth and yield, inventory, and silvicultural elements of NTMPs is based on the concept of truthful self-reporting, with an increasing level of scrutiny based upon the Department's confidence in the information and approaches used to demonstrate achievement of a balance between growth and harvest. Elements that the Department will consider in evaluation of NTMPs are described below.

Recognizing that demonstration of growth, harvest and sustainability is a performance-based approach, the general criteria described below should not be viewed as rigid guidelines which initiate specific actions on part of the Department. However, it is designed to highlight sensitive situations, which may lead the Department to conclude that more information may be needed to support the Department's judgment under 14 CCR § 897(d).

Derived Benefits of Participating in the NTMP Program

PRC § 4593.2(d) specifies that NTMPs shall demonstrate sustained yield following a management plan constructed about a prudent course of action that is professionally planned to achieve, over time, a balance between growth and harvest. In exchange for a clear program of timberland management, what makes the NTMP worthwhile to the non-industrial timber manager is:

- (1) The resulting sheltering affect from new rules.
- (2) Economic relief in not having to prepare future Timber Harvesting Plans, and
- (3) The approval of harvest activity in advance, thus allowing the land owner to take advantage of market fluctuations in a timely manner. (PRC § 4593(c))

Once the NTMP is approved, subsequent operations under the NTMP can be conducted under a simple notification, which is non-discretionary in nature and allows a landowner to begin operations under the notice immediately. This ability to begin operations with a harvest notice is what provides the greatest flexibility for the landowner as it pertains to scheduling of the harvests and ability to take advantage of fluctuations in timber markets. These elements have been extended to the plan proponent in exchange for a clear program for managing the timber stands contained within a plan, and for a certification by the RPF that operations:

² Society of American Foresters, John Helms, ed., *The Dictionary of Forestry*, The Society of American Foresters, 1998.

³ Wenger, Karl F., *Forestry Handbook*, New York: John Wiley and Sons, 1984.

- (1) Will implement best management practices for the protection of water, soil stability, forest productivity, and wildlife, or
- (2) Are consistent with the approved plan and will not result in significant degradation to the beneficial uses of water, soil stability, forest productivity or wildlife (PRC § 4594(h)).

The Rules applicable at the time of NTMP approval govern the plan over its lifespan, thus, to a degree, sheltering the NTMP from subsequent rule changes. This sheltering is subject to the certification standards of PRC § 4594(h). Examples of where sheltering may not be appropriate include, but are not limited to, newly listed species under the state or federal Endangered Species Act, or unforeseen catastrophic events.

Legislative Findings

As per PRC § 4593, the following are the legislative findings and declarations pertaining to NTMPs:

- (a) The Legislature finds and declares that a substantial acreage of timberlands of the state are held by private nonindustrial owners and that it is the policy of the state to increase the productivity of these timberlands under prudent management plans to serve the public's need for timber and other forest products.
- (b) The Legislature further finds and declares that minimal environmental harm is caused by prudent management of nonindustrial timberlands because low volume production and dispersion around the state of these small tracts reduces damage to aesthetics, air quality, watersheds, and wildlife.
- (c) The Legislature further finds and declares that it is the policy of the state to encourage prudent and responsible forest resource management of nonindustrial timberlands by approving nonindustrial timber management plans in advance and withdrawing governmental discretion to disapprove nonindustrial timber harvest notices submitted pursuant to the approved nonindustrial timber management plans.
- (d) It is not the intent of the Legislature by the enactment of this article to limit the penalties and the enforcement provisions of this chapter.

Demonstrating Balance of Growth and Harvest Using Uneven-aged Regeneration Methods and Other Appropriate Silvicultural Prescriptions

The Dictionary of Forestry (Society of American Foresters, 1998) defines a **management plan** as a *predetermined course of action and direction to achieve a set of results, usually specified as goals, objectives, and policies—note a management plan is a working instrument that guides actions and that changes in response to feedback and changed conditions, goals, objectives, and policies.*

The enabling legislation and Rules require that NTMPs must provide and demonstrate a clear program for managing the timber stands that meets the objectives specific to the individual non-

industrial tree farmer. This is evidenced by PRC § 4593.3(f) that states {emphasis added}, “*a description of the existing stand, its current projected growth, alterations required to achieve the management objectives, the projected timber volumes and tree sizes to be available for harvest, and projected frequencies of harvest shall be part of the public record.*”

In general, both the Act and the Rules set forth a set of performance standards for NTMPs focused on uneven-aged management and balancing growth with harvest to insure sustainability of the harvesting planned under the NTMP. Growth and harvest are developed around the landowner’s objectives while at the same time being subject to the provisions of the Rules, which are in effect at the time the NTMP is approved. The performance-based approach associated with demonstrating sustainability of harvest activities under an uneven-aged silvicultural application can be expected, and has led to, differing opinions between RPFs and the Department regarding how much information is necessary to demonstrate conformance with the Act and the Rules.

The Department recognizes four core elements that define a management plan. These elements include the following:

- (1) Proper establishment of the baseline conditions;
- (2) Identification of stocking levels that optimizes site productivity for the given products desired and that balances harvest with growth into perpetuity;
- (3) Defining the suite of intermediate or transitional prescriptions that leads to sustainable stocking levels; and
- (4) Monitoring.

The Department’s expectation is that at the point at which growth and harvest are balanced for a particular management unit, the management objectives and demonstration of sustainability required in PRC § 4593.2 (d) will need to conform to the standards reflected in 14 CCR § 913.2 [933.2 and 953.2] “Regeneration Methods Used in Unevenaged Management.” These regeneration methods include Selection and Group Selection and the applicable standards relative to post harvest stocking size and distribution of trees. In addition to Group Selection or Individual Tree Selection or both, there are associated intermediate treatments such as Commercial Thinning and Sanitation-Salvage and special prescriptions such as Fuelbreak and Special Treatment Areas, which are also appropriate in an NTMP. Where the management objectives include use of these methods, the NTMP analysis should account for these applications in the modeling and growth projections and should be described in sufficient detail for the Department to determine how these methods will influence MSP and long-term sustained yield (LTSY).

The differences between the current stand condition and the desired condition, based on landowner objectives, is a reality that needs to be recognized when developing and evaluating an NTMP. The variation on approaches to converting the current stand to the desired stand is limitless. This variation will be expressed through differences in characteristics such as stocking, species composition, and site productivity within an ownership and between ownerships. Furthermore, this is to be expected given these differences in consideration of landowner objectives and management constraints.

It will be the exception rather than the rule that NTMPs will apply Special Prescriptions to existing stands or intermediate stands. RPFs have an obligation to provide an adequate analysis of the planned management strategy through the period necessary to reach a regulated stand condition where growth and harvest are balanced. It can also be expected that this desired future condition should vary based upon site, species, and constraints. The key is that the RPF demonstrate in sufficient detail and provide adequate information on the projected series of silvicultural applications necessary to move the existing stand structures to the desired future conditions

NTMP Content

The NTMP information should reflect professionally accepted standards including stratification of the property into appropriate stands, designation of management units, aggregation and display of stand information, the underlying inventory used to support the stand projections, the modeling approaches utilized, and the silviculture to be applied towards the desired future condition. Some discussion of inventory methods should be included which outlines the sampling intensity, age of the inventory, timber typing and sample stratification approaches that were used. Guidance relative to inventory stratification is found in Appendix III. For inventories older than 5 years, the inventory should be updated and the methods to update the inventory should be described. Sufficient detail is expected in the NTMP to demonstrate that the desired future condition does balance growth with harvest, is reasonable in terms of harvest levels, and complies with MSP. The NTMP should lay out a planned application of silvicultural treatments that conforms to the Rules, meets rule intent, and can function as clear blueprint for management of the ownership under the terms of the NTMP if changes in ownership or RPF occurs.

The sustained yield demonstration in the NTMP should include the following information:

- The proposed management objectives, projected timber volumes and sizes available for harvest [14 CCR § 1090.5 (h)] for each stand within the established management units.
- For each management unit, the RPF should describe the desired future condition of the stand(s) in terms of pre-harvest stocking, volume available for harvest, post harvest stocking, and growth. The RPF should demonstrate that:
 - ❖ The projected inventories are sustainable based on the indicated cutting cycle length, and harvest intensity and
 - ❖ The volume available for harvest represents a level that is feasible for the prescribed logging system.
- A description of the current condition of stand(s) for each management unit.
- A description of how the planned schedule of management activities will achieve the desired future condition(s) for each management unit.

PRC § 4593.3(f) and 14 CCR §§ 1090.5(g), (h), (i), and (j) require that each NTMP contain the following information:

- Designation of management unit(s)⁴ for the NTMP.
- For each management unit the following information should be provided:
 - ❖ The current timber stand(s) characteristics.
 - ❖ The stand characteristics at the point where growth and harvest will be balanced.
 - ❖ The silvicultural prescriptions to be applied at each harvest entry to move the existing stand structure(s) to the desired future condition for the management unit(s) and the ownership as a whole.
- Pre- and post-harvest descriptions of stand(s) at each harvest entry should include information on species composition, stocking levels, volume per acre, and size class distribution.
- Silvicultural method to be applied at each entry to the stand(s) within the management unit(s), projected frequencies of harvest entries, and type of yarding methods to be used.

⁴ The Forest Practice Rules provide some guidance as to what constitutes a management unit, which may or may not apply to an NTMP. 14 CCR § 1091.3 defines "Management Unit" as: *"the part or parts of timberland ownership which are analyzed together as part of an SYP and may include areas outside of an ownership when addressing watershed and wildlife issues. The Management Unit shall be limited to one forest district. The landowner has the option of including within their management unit their entire ownership within the forest district and any areas outside the district that the Director agrees are part of a logical management unit, or they may divide the ownership into management units based on administrative, regulatory and ecological factors with concurrence from the Director. The Management Unit must include one or more planning watersheds, and may include associated resource assessment areas."* The Rules definition is comparable with Davis and Johnson (1987), which defines a management unit as *"a geographically contiguous parcel of land containing one or more stand types and usually defined by watershed, ownership, or administrative boundaries for purposes of locating and implementing prescriptions. A management unit is usually larger than a stand and typically contains many stand types and individual stands (synonyms: heterogeneous planning unit, allocation and scheduling zone, administrative area)"* (p. 29). The authors further discuss management units under the section entitled "Stand Type or Management Unit Classification for Planning?" They note: *"Stand types organize the land of a forest into classes that are homogeneous with regard to some basic land characteristics in order to predict timber yields and other responses of the land to treatments with confidence. Management units, in contrast, organize the land into logical spatial units for purposes of implementing a plan and to deal with concerns or impacts that are inherently spatial in character, resulting in land units that are typically nonhomogeneous"* (p. 33). From: Davis, Lawrence S., K. and Norman Johnson, Forest Management, Boston: McGraw Hill, 1987. Davis et. al. discuss management units and note that, in general, such an area is *"...a parcel of land that has been identified for the purpose of coordinating the selection and implementation of stand prescriptions. Management units are often set up to address the issues raised by measurement of cumulative effects and to provide a focus for plan implementation"* (p. 84). They also note: *"Management units are administratively defined areas which can be stands, watersheds ownership parcels, or other areas"* (p. 761). From: Davis, Lawrence S., K. Norman Johnson, Peter S. Bettinger, and Theodore E. Howard, Forest Management, Boston: McGraw Hill, 2001.

Silviculture

In addition to the Selection and Group Selection uneven-aged systems specified under 14 CCR § 913.2(a) [933.2(a), 953.2(a)], the following silvicultural treatments are permitted in a NTMP:

- Transition { 14 CCR § 913.2(b) [933.2(b), 953.2(b)]};
- Intermediate Treatments { 14 CCR § 913.3 [933.3, 953.3]}, which include Commercial Thinning and Sanitation-Salvage;
- Special Prescriptions { 14 CCR § 913.4 [933.4, 953.4]}, which include Special Treatment Area Prescriptions, Rehabilitation of Understocked Area Prescriptions, Fuelbreak/Defensible Space prescriptions, and, with exception, Variable Retention (VR) prescriptions. (VR will be allowed as long as the prescription establishes a convincing case to the Director that it is consistent with the goals and objectives of the NTMP legislation.)

Again, where the management objectives include use of these methods, the NTMP analysis should account for these applications in the modeling and growth projections and should be described in sufficient detail for the Department to determine how these methods will influence MSP and LTSY.

The Department will not allow VR prescriptions in a NTMP where the prescription bears a resemblance to an even-aged method. VR prescriptions will be allowed as long as the RPF establishes a convincing case to the Director that it is consistent with the goals and objectives of the NTMP legislation and the provisions of the Board Rules in effect at the time the NTMP is approved.

NTMPs submitted under an Option C demonstration of MSP can propose Intermediate Treatments or Special Prescriptions and meet MSP under 14 CCR § 913.11(c)(3) [933.11(c)(3) & 953.11(c)(3)], which specifies “For intermediate treatments and special prescriptions, complying with the stocking requirements of the individual treatment or prescription.” This is allowed provided the submitter conducts an appropriate quantitative analysis, which discloses how application of the prescription will support achievement of the desired future condition for each stand. The quantitative analysis should be consistent with the Department memo, “Revision of CDF policy regarding the applicability of intermediate treatments for NTMPs that demonstrate MSP by Option C [(14 CCR 913.11-, 933.11-, 953.II-(c))” dated July 15, 2002, and attached as Appendix IV.

Also, as discussed previously under the “NTMP Content” section, silvicultural applications should be described for each stand by management unit for each entry during the period of time necessary to bring the stand into a regulated condition. However, at a minimum the descriptions should be of sufficient detail for the Department to determine the feasibility of the planned silviculture in terms of achieving and maintaining the desired future condition.

Demonstration of MSP--*Important Concepts*

Sustained Yield versus LTSY

As defined in PRC § 4593.2 (d), “sustained yield” means *“the yield of commercial wood that an area of commercial timberland can produce continuously at a given intensity of management consistent with required environmental protection and which is professionally planned to achieve over time a balance between growth and removal.”*

Conversely, long-term sustained yield (LTSY) is defined as *“the average annual growth sustainable by the inventory predicted at the end of a 100 year planning period.”* A critical element in harvest scheduling is the defining and implementing a series of planned silvicultural prescriptions. In situations where the desired crop takes 50 to 100 years to mature, the purpose of a 100 year planning horizon is estimate the long-term outcomes of applying the planned program of management prescriptions over time. Additionally, the calculation of LTSY defines a threshold that harvest levels may not exceed when averaged over a rolling ten-year period..

“Sustained yield” should not be confused with “LTSY” even though both terms are applicable to the demonstration of MSP for NTMPs (refer to 14 CCR § 913.11 [933.11, 953.11](c)(4)). Furthermore, 14 CCR § 1090.5(j) requires that the time period for balancing growth and harvest be identified in the NTMP; this coincidentally satisfies the sustained yield objective of PRC § 4593.3. In most cases, once an inventory reaches the point where growth and harvest can be sustained, LTSY has been demonstrated as well. The sustainable harvest level will need to reflect the range of site productivity, species mix, and current environmental constraints under the desired future management conditions.

The point at which all fully managed stands in the identified management units have reached a balance between growth and harvest is the point at which the NTMP as a whole meets the Act and Rule requirements (i.e. the sustained yield objective of the Act and the long term sustained yield requirement of the Rules). It should be noted however, that some stands, given applicable constraints, may not achieve a balance between growth and harvest for a period of time exceeding 100 years. For example, sustained yield might not be achieved until year 130 (growth and harvest are not balanced within 100 years due to poor site productivity or the need to rehabilitate mismanaged stands or both). In cases such as this, the annual projected yield must be limited so that the harvests not exceed the growth considered sustainable by the inventory at 100 years (LTSY) for any rolling 10-year period. When and if this situation arises, the RPF should disclose and discuss any instance where the balancing of growth and harvest is unachievable within the 100-year planning period in light of the constraints and identify the desired future condition and the harvest proposed for these stands. It should not be required that the growth and harvest be balanced within the 100-year planning period, but, rather, the emphasis should be on verifying that the harvesting planned for these areas is consistent with the constraint. For example, if the stands on a particular NTMP continue to increase in volume because the desired condition has not yet been met, the RPF should be prepared to discuss how the balance will be achieved with an estimate of timing. Any associated modeling effort should

also demonstrate that the stand is moving towards the desired future condition reflected in the RPF's discussion.

Option “B” or “C” Demonstrations

The options for NTMPs to address MSP are either 14 CCR § 913.11 [933.11 and 953.11] (b) or (c), simply referred to as option “B” or option “C.” Important concepts about MSP that distinguish it from sustained yield include the following:

- Production of high quality timber products;
- Enhancing or restoring timberland productivity to improve site capacity to realize increase yields;
- Defining minimum sized seed trees in terms of DBH that are considered to have reached a maturity to produce viable seeds,
- Defining minimal density standards and rotation periods to prevent site degradation, and
- Protecting the soil, air, fish and wildlife, water resources and any other public trust resources.

“Sustained yield” is the harvest schedule solution that accounts for these components of MSP.

Two components that chiefly distinguish an option “B” or an option “C” are the seed tree standards and planning horizons. “Option c” includes specific parameters that define seed trees, whereas under an “option b,” the landowner may define different standards. Secondly, the planning horizon for an “option b” is defined for a period of 100 years, whereas an “option c” relies on meeting the standards set forth in 14 CCR § 913.11(c)(2)-(3) [923.11(c)(2)-(3), 953.11(c) (2)-(3)]. However, when option “C” is chosen, per 14 CCR § 1090.5(j) there still remains a requirement to describe the period of time over which growth will be balanced with harvest. The NTMP will need to adequately demonstrate how and when this will occur.

Option C: Compliance with the MSP standards of 14 CCR § CCR 913.11(c) [933.11(c), 953.11(c)] should not be viewed as equivalent to compliance in the obligation to demonstrate sustained yield as defined in PRC § 4593.2(d). PRC § 4593.3 makes meeting the objectives of sustained yield a requirement. If option “C” under 14 CCR § 913.11 [933.11, 953.11](c) is selected, the focus on the demonstration of sustained yield should be to the point where growth and harvest are balanced, and demonstration of how the requirements of 14 CCR § 913.2 [933.2, 953.2] {seed trees} will be met. Growth and harvest may be balanced with the first entry or several cutting cycles may be required.

NTMPs submitted under an option “C” demonstration of MSP can propose Intermediate Treatments or Special Prescriptions and meet MSP under 14 CCR § 913.11(c)(3) [933.11(c)(3), 953.11(c)(3)], which specifies the following:

For intermediate treatments and special prescriptions, complying with the stocking requirements of the individual treatment or prescription.

However, when the silviculture prescription cannot meet the Seed Tree retention standards (14 CCR § 913.1 (c)(1)(A) [933.1 (c)(1)(A), 953.1 (c)(1)(A)], the submitter must establish a

convincing demonstration for the Director that the objective of uneven-aged management is attainable within the specified timeline. See appendix IV for further discussion of requirements.

Option B: If a plan submitter elects to use option “B”, the expectation would be that the LTSY would be estimated based on a 100-year planning period, but as stated earlier, if growth and harvest is balanced, the level of growth and inventory at which this occurs, for all practical purposes, will be the same at the end of the 100-year projection.

What Constitutes a “Demonstration?”

The terms “demonstrate” and “demonstration” occurs over 20 times in the Act and Rules. Webster’s 9th edition defines these terms by the following:

- *To show clearly;*
- *To prove or make clear by reasoning or evidence;*
- *An act, process, or means of demonstrating to the intelligence; and*
- *A showing of the merits of a product or service to a prospective consumer.*

An NTMP is more than a California Environmental Quality Act (CEQA) harvest permit (i.e. THP). Besides satisfying the Rules and CEQA, an NTMP is a management plan which is required to demonstrate how the plan will meet MSP and sustained yield. MSP is addressed in 14 CCR § 913.11 [933.11, 953.11] and sustained yield is addressed in PRC § 4593.2(d). The Department must be able to verify implementation with the original projection(s). Plans in which the demonstration is verifiable at only a future point in time, such as a re-inventory point, do not necessarily allow CDF to assess compliance with PRC § 4594.7. This section clearly requires that the Department must be able to determine if the objectives of the Act have been met. PRC § 4594.7, **cancellation of plan by department** provides the following:

If it is determined that the objectives of uneven aged management and sustained yield are not being met by a nonindustrial tree farmer, or there are other persistent violations detected that are not being corrected, a previously approved nonindustrial timber management plan shall be canceled by the department and any further timber operations under the plan shall be terminated.”

Data Presentation

The demonstration of sustained yield should reflect differences in site and species composition, as well as the environmental constraints applicable to the NTMP. In most cases, it is reasonable to assume that variation in site class, species mix, and environmental constraints will lead to a different solution relative to sustained yield for the management unit(s) described in the NTMP. The NTMP should reflect an appropriate level of stratification to support these different solutions and, where it appears that some level of stratification along these lines would be necessary, plan submitters should not be surprised if the Department directs questions to the RPF when this is not done.

Because the Department has a review responsibility to evaluate the adequacy of the modeling and the associated stratification components that go in to developing growth and yield projections. To facilitate this review the RPF preparing the NTMP growth and yield projections should present information in formats that are commonly used within the professional practice of forestry. In that regard, the uses of stand tables are essential and universally recognized for communicating characteristics of a stand. For each stand type identified within each identified management unit, data format should consist of a single stand table that displays the average number of stems by each species and DBH class. Optimally, each stand table would be paired with a stock table. Regardless, each stand table should provide a sufficiently detailed summary of the diameter class distribution of Group A species to permit Department evaluation. The table(s) should present 2-inch diameter classes⁵ on a per-acre basis by species. Group B species should be reported by 2-inch diameter classes but hardwood species may be lumped under one column if there is no reason to appraise a certain specie representation separately.

Successful unevenaged management is predicated on “*establishment and/or maintenance of a multi-aged, balanced stand structure*” (14 CCR § 913.2 [933.2, 953.2]), and *sustained yield* is predicated on managing existing age class distributions and creating new age classes with each harvest. To assist the Department in evaluating sub-merchantable age class distributions, stand tables should include density measures by diameter classes no greater than 2-inches, and should include the “0” DBH class. This information will be used to:

- (1) Establish baseline conditions, so that the RPF and Department can, over time, appraise silvicultural success in establishing new age classes; and
- (2) Prevent a potential species shift or conversion in a stand composed of desirable conifer species to one composed of undesirable species.

Where single-tree selection is planned on site class 4 and 5 timberlands, 1-inch DBH class resolution is recommended for regeneration size trees in order to appraise new age-class recruitment & development. On poor sites, the time span for a 1-year seedling to grow in size to a 1-inch DBH tree is roughly 10-20 years, that in absence of baseline data, could translate into a significant delay of several decades before deficiencies are recognized, thus translating into delayed yields and delayed financial opportunity for the landowner.

Growth projections for uneven-aged management will need to include reasonable estimates of ingrowth in absence of objective data. The RPF should discuss how ingrowth was factored into the growth projections. The RPF must recognize that when sampling for the non-merchantable classes, differentiation must be made between trees capable of developing into a future crop tree and those having poor form and vigor, which are likely not capable of developing into a crop tree.

⁵ From: Arvola, T. F., California Forestry Handbook, Sacramento: Department of Forestry, 1978, p. 73 and Wenger, Karl F., Forestry Handbook, New York: John Wiley and Sons, 1984, p. 281.

Commonly Used Models for Growth and Yield Projections

Acceptable models for demonstrating this requirement include, but are not limited to, CACTOS, CRYPTOS, FVS, stand table projection, or any validated proprietary individual-tree simulation models capable of equivalent detail.

RPFs are expected to be aware of the practical limitations of growth and harvest models, which are presented in the NTMP and draw appropriate conclusions relative to the outputs. Some of the limitations associated with various modeling techniques are described in a 1999 USDA Forest Service Pacific Southwest Research Station publication, “A Compendium of Forest Growth and Yield Simulators for the Pacific Coast States,” by Martin Ritchey⁶, which is available online at (<http://www.fs.fed.us/psw/publications/documents/gtr-174/gtr-174-cover.pdf> and <http://www.fs.fed.us/psw/publications/documents/gtr-174/gtr-174-content.pdf>).

Projections are only as reliable as the underlying data supporting them. Projections should not be viewed as absolutes or enforceable standards in and of themselves. They do, however, provide a guide against which to evaluate trends and serve as the basis for adjustments if inventory information indicates that the projections need to be adjusted upward or downward.

Re-evaluations

An assessment of sustained yield is a measure or a forecast of what a forest that is regulated to the structure a landowner desires can produce without depleting its productive capacity. Re-evaluations are an important aspect in long-term planning and are necessary to evaluate original projections with actual progress. In Forest Management (Davis and Johnson, 1987) the authors’ position on this subject is presented below:

*The empirical core of our claim to manage land scientifically and to ensure that owner objectives are met lies in our ability to predict quantitatively the future characteristics of current and regenerated stands of a given stand type managed under a specific prescription. If we cannot predict with acceptable accuracy, then it is hard to convince our clients that their goals are being met and that we foresters really know what we are talking about. Concepts are one thing, but the real world wants to know how much!*⁷

For properties where initial post-harvest stocking falls below the selection standards, which propose to utilize a series of silvicultural applications over time to create the desired stand conditions, the Department will be looking for commitment from the landowner to conduct sufficient stand inventories to monitor and record actual stand performance against modeled performance. It is conceivable that re-inventories may not be necessary for long periods if actual inventory levels reasonably track with original projections. Inventory design should follow

⁶ Ritchie, Martin W., A Compendium of Forest Growth and Yield Simulators for the Pacific Coast States, USDA Forest Service General Technical Report PSW-GTR-174, 1999.

⁷ Chapter 2: Elements of Forest Management. **Stand Prescription and Growth Projections**, pg 35.

conventional forestry standards and the intensity and design of inventory strategies should be flexible enough to recognize different stand conditions and capabilities.

CDF's Approach to the Review of NTMP Growth and Yield Related Information

The following describes CDF's approach to the review of the growth and yield portion of an NTMP. The approach uses a tiered system, whereby the Department may identify situations that may demand more attention than others. Such situations depend on the contents, methodology and assumptions built into the growth and yield information contained in an NTMP and the Department's comfort level with the final projections. Use of the tiered approach allows the Department to ascertain the conditions or analysis methods or both that will precipitate a more detailed review in order to clearly understand the proposed management strategy. For example, group selection is a common silvicultural method. However, it is intrinsically difficult to model compared to individual tree selection. The tiered system may indicate a more detailed review when one proposes use of such a silvicultural method.

The criteria relate to the existing conditions, the characteristics of proposed management, or the methodologies and assumptions utilized in determining the results, or all three. Three tiers, or levels of detail of review, along with the criterion for placing an NTMP into one of the tiers, are defined. Each tier builds on the previous tier, so that each criterion and review recommendation includes those in previous tiers. For example, in tier 2 review, one would examine all the issues listed under tier 1 as well as tier 2.

Inventory

Tier 1 Criterion: A recent inventory of the property, less than 5 years old.

Tier 1 Review:

- (1) Do a quick check of inventory figures against applicable yield tables for the area, or rely on professional experience with the area.
- (2) Determine the sufficiency of the sample design.
- (3) Determine the inventory method (i.e. plot distribution, fixed v. variable, etc.)
- (4) Determine the cruise specifications (i.e. what was measured and how).

Tier 2 Criterion: Inventory more than 5 years old, but updated for growth and harvest.

Tier 2 Review:

- (1) Examine update methodology, including growth and harvest estimates, and assumptions.

Tier 3 Criterion: Inventory more than 5 years old, not updated or no estimate of standard error, or standard error greater than 15 percent.

Tier 3 Review:

- (1) Request an update for growth and harvest.

- (2) Detailed examination of inventory calculations and estimate the probable level of accuracy and magnitude of possible error. If significant, request the landowner scale back planned harvests to allow for possible error.
- (3) Possibly require a re-inventory of the property either for initial plan review or some specified time period in the future depending on actual current stand conditions.

Growth Projections and Harvest Schedule

Tier 1 Criterion: Growth projections developed with a well known publicly available growth model (Cactos, Cryptos, FVS, Organon, FPS), and models are used within their limits, with no appropriate model calibrations.

Tier 1 Review:

- (1) Verify that models were used within their limits (i.e. no “free grow” with no harvest, Cryptos was not used in the Sierra, etc.)
- (2) Verify that growth projections generally match observed growth rates in the area.
- (3) Determine how harvesting was facilitated in the model.
- (4) Determine how the mortality was accounted for.
- (5) Determine how ingrowth was accounted for.
- (6) Determine what volume tables were used and what merchantable top diameter was applied (for example, in CACTOS, this information is within the coefficient file).
- (7) Determine how the user ran the model (i.e. interactive, batch, linear program, user specified, etc.)

Tier 2 Criterion: Growth projections developed with unpublished growth models, stand table projections or empirical data, but well documented and defensible or published growth models are used, but calibrated with local data.

Tier 2 Review:

- (1) Examine whether assumptions used in modeling are realistic.
- (2) Request data to back up calibrations.

Tier 3 Criterion: Growth projections developed with published or unpublished growth models or both or empirical data and appear to be over-generalized, have a lack of specificity or appear to be outside of design capabilities for the method used. Also, estimated growth rates not supported by observed growth rates in the area based on direct observation (i.e. PHI), experience, or yield tables.

Tier 3 Review:

- (1) Request detailed justification of all assumptions (e.g. computation of movement ratios).
- (2) Examine all aspects of the analysis and make an assessment of the possible effects of cumulative errors from all sources.
- (3) It may be necessary to lower estimates of growth and harvest to more conservative levels to allow for wide confidence limits on estimates.

- (4) Possibly require a re-inventory of the property at some specified time period in the future depending on actual current stand conditions and the prescription being applied.

Silviculture

Tier 1 Criterion: Residual basal areas generally well above the minimums in the FPR for all silvicultural methods. Only selection, commercial thinning, or sanitation salvage or all three are used.

Tier 1 Review:

- (1) Verify silvicultural applicability to the existing stand conditions. For example, commercial thinning requires that the average stand diameter increase or that the prescription improves forest health; therefore, it is incumbent that the application, as demonstrated in the field and within the projections, meets this requirement. For selection, it is incumbent that the application, as demonstrated in the field and within the projections, addresses current imbalances in age class distributions and provides provisions for establishment of new age classes.

Tier 2 Criterion: Alternative methods, group selection or silviculture consistently modeled to the minimum retention standards in the FPR.

Tier 2 Review:

- (1) Review the need for alternative methods.
- (2) Review growth projections for group selection to verify that yields are realistically achievable in the area.
- (3) Clarify landowner objectives for MSP and insure that a clear methodology is presented that achieves those objectives.
- (4) Request information that demonstrates the alternative prescriptions are moving towards an uneven-aged distribution.
- (5) For selection and transition methods, plan should address current imbalances in age class distributions, provide provisions for establishment of new age classes, and provide monitoring in age class development.

Tier 3 Criterion: Ambitious plans for intensive management that boosts projected growth that is not supported by current or recent past management history. This may be evident by declining standing inventories or large diameter classes being removed in the early planning years. Also, alternative methods that go below the retention standards of the nearest standard method or where it is not clear that an uneven-aged stand is being established.

Tier 3 Review:

- (1) Compare silviculture with past history, with an economic feasibility component.
- (2) Request detailed justification for assumptions.
- (3) Some monitoring agreement may be in order if questions or feasibility remain an issue.

Both the Act and the Rules require RPFs and the Director to utilize professional judgment when proposing and evaluating plans. Therefore, the criteria presented above should not be utilized as

a checklist for the review of NTMPs, nor should it be referenced as the criteria by which NTMPs are determined to be in conformance with the rules. The tiers presented above are intended to provide some guidance in the review of NTMPs. They are not intended to provide the sole criteria by which NTMPs are evaluated. They simply serve to illustrate the potential thought process that a reviewer of NTMPs may utilize in determining if the information in the NTMP complies with the provisions of the Forest Practice Act and Rules.

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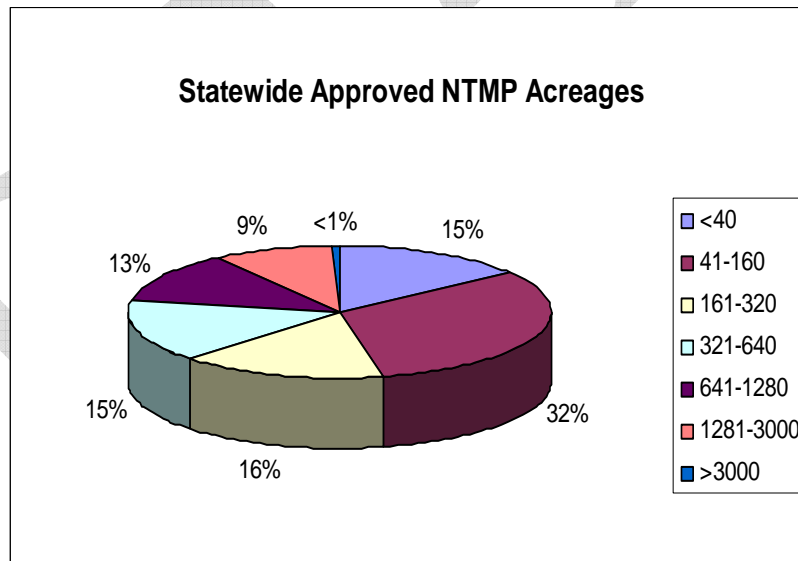
APPENDIX I

Information about NTMP Submissions, Return Rates, Reasons for Return, etc.

Since 1991 there have been 640 NTMPs submitted statewide and 601 approved.

| Administrative Region | Approved NTMPs | Acres Approved |
|-----------------------|----------------|------------------|
| North Coast Region | 453 (75%) | 208,158 (76%) |
| Cascade Region | 96 (16%) | 43,637 (16%) |
| Central Sierra Region | 52 (9%) | 22,478 (8%) |
| Total | 601 | 274,273 |

Individual NTMP acreages range from 8 acres to 5131⁸ acres, with an average of 456 acres and the following distribution:



⁸ NTMPs greater than 2500 acres have multiple landowners under on management plan. Each individual landowner must own less than 2500 acres pursuant to PRC § 4593.2(b).

While the NTMP program has been utilized to the benefit of landowners on the Coast and Interior areas, NTMP review-related issues have led to high rates of plan return. The Department, in response to complaints from RPFs and concern expressed before the Board of Forestry, compiled the following statistics for 2003 to present NTMP return rates:

2003 to present—Non-Industrial Timber Management Plans (NTMPs), Frequency of Return

TABLE 1: Number of “First Submittal” plans reviewed and the corresponding number returned (As of September 26, 2005)

| North Coast Region | | Cascade Region | | Central Sierra Region | | State Wide | |
|--------------------|----|----------------|----|-----------------------|----|------------|----|
| Reviewed | 40 | Reviewed | 23 | Reviewed | 12 | Reviewed | 75 |
| Returned | 19 | Returned | 3 | Returned | 5 | Returned | 27 |

TABLE 2: Percentage of plans returned

| Harvest Document Type | North Coast Region | Cascade Region | Central Sierra Region | State Wide TOTAL |
|-----------------------|--------------------|----------------|-----------------------|------------------|
| NTMP | 48% | 13% | 42% | 36% |

Reasons for Return

TABLE 3: General reasons for plans being returned to the submitter.

| Return Issues (pursuant to 14 CCR & PRC) | Occurrences | | |
|--|-----------------------|-------------------|-----------------------------|
| | North Coast Region | Cascade Region | Central Sierra Region |
| Notice of Preparation (14 CCR § 1090.2) | 9 | | |
| Domestic Water Notice Issues { 14 CCR §§ 1090.2(g) & 1032.10} | 12 | 1 | |
| Archaeology Issues (14 CCR § 929) | 10 | 1 | 1 |
| Silviculture Issues (14 CCR § 913.4 [933.4, 953.4]) | 3 | | 1 |
| 14 CCR § 897(b)(3) Issues* | 6 | | 2 |
| 14 CCR §§ 1090.5(g), (h), (i), or (j) or all four | 11 | | 2 |
| Alternative Practice 14 CCR § 916.6 [936.6, 956.6] | 2 | | |
| 14 CCR § 1090.5(a), PRC § 4527, | 2 | | |
| Timberland Owner | 9 | | |
| Maps | 3 | | 1 |
| Other | 7 | 1 | 1 |
| Total** | 74 | 3 | 8 |

* Those plans identified as being returned under 14 CCR § 897(b)(3) had several rule requirements missing from the plan (some of which could be listed above), or was presented with so many inconsistencies or inaccuracies that it was not clear what was being proposed in the plan or both.

** A returned plan may have been returned for multiple reasons.

APPENDIX II

CDF Review Guidelines for CDF Review Team Staff Evaluating Maximum Sustained Production in Nonindustrial Timber Management Plans (NTMPs) (Originally circulated 10/30/95) (Updated 09/19/05)

1. PURPOSE AND NATURE OF THE REVIEW GUIDELINES

These review guidelines have been developed for use by the California Department of Forestry and Fire Protection (CDF) staff reviewing NTMPs submitted under Option “B” (14 CCR § 913.11(b) [933.11(b), 953.11(b)]) or Option “C” (14 CCR § 913.11(c) [933.11(c), 953.11(c)]) of the state forest practice rules in California. Such guidelines are necessary because 14 CCR § 913.11(b) [933.11(b), 953.11(b)] requires advanced level quantitative analysis with many procedural variations. This is also the case with 14 CCR § 913.11(c) [933.11(c), 953.11(c)] since NTMP submitters are required to balance growth and harvest over time. Also, the rule language in 14 CCR § 913.11(b) [933.11(b), 953.11(b)] and the supporting findings provide CDF staff with substantial discretion in enforcing the rules. The guidelines are as general as possible so as to allow application to different forest types and regions, while at the same time providing the necessary practical guidance to CDF staff to allow consistent and fair application of the state forest practice rules.

2. ALL NTMPs

2.1 BALANCING GROWTH AND HARVEST OVER TIME

Although option C does not require demonstrating LTSY as under option “A” or “B,” PRC § 4593.3(g) and 14 CCR §§ 1090.5(h)-(j) require demonstrating a balance of growth and harvest over a time period selected by the submitter.

2.1.1 Inventory Estimates

PRC § 4593.2 defines sustained yield for NTMPs. Showing the balance of growth and removal over time requires an estimate of current inventory.

Informational elements:

- a. An estimate of current standing inventory of the NTMP area, by management unit, in terms of species composition, age classes, stocking, volume per acre, and size class distribution. (14 CCR § 1090.5(g)).
- b. A description of the sampling procedure used to collect the inventory data. Information should include basic information such as inventory design, cruise methods (fixed-radius

plots, variable-radius plots, or a mixture of both), cruise intensity, and information collected on each plot.

- c. A description of data processing procedures. Information should include methods and equations used in developing inventory estimates such as basal area and volume from raw data, units of measure, and merchantability limits.
- d. An estimate of the precision of the inventory estimates in the units of measure used by the submitter to illustrate the balance between growth and harvest. Although no explicit inventory precision requirement is in the forest practice rules, an estimate of precision should be included to allow the Department to evaluate the validity of the inventory as a basis for subsequent growth projections and harvest scheduling analysis. A description of the equations, methods, and intermediate calculations should be included to allow CDF to verify the validity of the estimates.

Review Guidelines:

The amount of detail and level of scrutiny to assign to review of items a. - d. above will vary according to the characteristics of the inventory as described by the submitter. If an up-to-date, complete inventory of the NTMP area is presented, with inventory estimates falling within expected ranges, a detailed review of data and methods is probably not necessary. If there are clear gaps in data or methods such as incomplete coverage of the NTMP area or old data, CDF will ask the submitter for additional information including a discussion of how these shortcomings might affect the projections of growth and harvest.

2.1.2 Growth Projections

Reliable growth projections are essential to balancing growth and harvest over time. However, because of the large number of variables involved, growth projection evaluation is probably one of the most difficult tasks in NTMP evaluation. If a stand table projection is used, the maximum desired period of projection is 15 years. The assumptions of consistent height-to-diameter relationship, representative local volume table, and growth rates do not allow a longer projection using this method. The assumptions of mortality and particularly ingrowth are important in validating the sustainability of the projections. This data may be used in the future to determine the success of the projections and aid in determining whether the objectives of uneven-aged management and sustained yield are being met (PRC § 4594.7).

Information Requirements:

- a. Model documentation. If a publicly available growth and yield model is used, such as CACTOS, CRYPTOS, or FVS (Prognosis), submitters should document all the user-specified options of the models, such as calibration to local conditions, merchantability limits, mortality, and ingrowth. Such documentation should establish the suitability of the model to the site.
- b. A description of all the silvicultural prescriptions used in modeling growth over time.

Review Guidelines:

Local expertise and published growth information should be the primary evaluation criteria for growth projections. Growth projections that fall within reasonable and expected ranges should not require detailed scrutiny. CDF will require more detailed explanation of growth projections that fall substantially above or below what would be expected in a particular area.

2.1.3 Planning Horizon

The submitter may select the planning horizon length, but it should be long enough so that sustainability may be evaluated. This includes showing how the minimum of 12-15 ft²/acre of greater than or equal to 12-to-18-inch dbh trees are to be maintained (depending on whether 14 CCR § 913.1 (c)(1)(A) [933.1 (c)(1)(A), 953.1 (c)(1)(A) or 913.2(b)(6) [933.2(b)(6), 953.2(b)(6)] apply).

Information Requirements and Review Guidelines:

A harvest schedule spanning the submitter-defined planning horizon as per 14 CCR § 1090.5(j).

3. ADDITIONAL REQUIREMENTS FOR USING OPTION "B"

3.1 BALANCING GROWTH AND HARVEST OVER TIME

3.1.1 Growth Projections

14 CCR §§ 913.11(a)(2) and (b)(4) [933.11(a)(2) and (b)(4), 953.11(a)(2) and (b)(4)] require an estimate of LTSY and further require that harvest in all planning periods must be less than or equal to the LTSY estimate. Growth projections over a 100-year planning horizon are necessary to estimate LTSY by the definition in 14 CCR § 895.1. In order to evaluate the validity of the LTSY estimate, CDF also needs to evaluate the growth projections on which the LTSY estimate is based.

Additional Information Requirements:

- a. Examples of 100-year growth and harvest projections for representative cover types, site classes, and silvicultural prescriptions found on the NTMP area. Enough projections should be submitted to enable CDF to evaluate the validity of the projections across representative conditions found on the NTMP area.

3.1.2 Long Term Sustained Yield (LTSY)

14 CCR § 913.11(b)(4) [933.11 (b)(4), 953.11 (b)(4)] requires an estimate of LTSY and further require that harvest in all planning periods must be less than or equal to the LTSY estimate.

Because of the large number of intermediate calculations that go into the LTSY estimate, CDF needs information on the harvest scheduling model as well as the LTSY calculations in order to determine the validity of the LTSY estimate.

LTSY is defined in 14 CCR § 895.1 as "the average annual growth sustainable by the inventory predicted at the end of a 100 year planning period." This definition is based on the idea that in a sustainable forest, growth will equal harvest (Davis and Johnson⁹). Meeting the BOF definition necessarily requires estimating average growth on after-harvest inventory in the last planning period and demonstrating that this growth is sustainable.

NTMP submitters may use proprietary harvest scheduling models or substitute a sequential stand-by-stand growth and yield analysis in lieu of a formal forest-wide harvest schedule. This is acceptable, however, it is still the submitter's responsibility to track total growth across the NTMP area over 100 years to estimate LTSY by the BOF definition.

Information Requirements:

- a. A technical description of the harvest schedule, sufficiently detailed to satisfy reviewers that the resulting LTSY estimate is defensible. Less detailed descriptions would be required for well known analysis tools such as SARA than for proprietary models developed by the landowner. The documentation should contain a complete description of land base strata, silvicultural prescriptions used, and all assumptions pertaining to the harvest schedule. Plans for discretionary investments in future growth enhancing treatments can be supported by historical records of similar current investments.
- b. An estimate of the resulting LTSY, a demonstration of the sustainability of that estimate, and a description of how the estimate was reached. This should include a list of the LTSY contributions from the major strata or logical stand groups used in the analysis. This list of LTSY contributions is necessary for CDF to establish the validity of the estimated LTSY.
- c. Description that shows harvest in each planning period is less than the LTSY. This requirement is probably most easily met by providing a table showing growth on residual inventory, harvest, and pre- and post-harvest inventory in each planning period.

3.1.3 Planning Horizon

The BOF findings state:

"... Should they choose to use (a) or (b) they will be required to balance growth and harvest over time (over the 100 year planning horizon)."

Also, as noted in the definition of LTSY, a planning horizon of 100 years is required to estimate LTSY.

⁹ Davis, Lawrence S., K. Norman Johnson, Peter S. Bettinger, and Theodore E. Howard, Forest Management, Boston: McGraw Hill, 2001.

Information Requirements and Review Guidelines:

A harvest schedule as described above developed over a 100-year planning horizon, which includes growth on residual inventory in the last planning period.

3.1.4 Consistent Prescriptions

In addition to forest regulation issues, consistent prescriptions over time are a basic assumption in harvest scheduling. All other factors constant, a shift toward conservative prescriptions in the latter part of the planning period increases the LTSY estimate, but violates this assumption. Because CDF is charged with ensuring that the LTSY estimate developed as part of demonstrating MSP under 14 CCR § 913.11(b) [933.11(b), 953.11(b)] is correct, CDF needs enough information to determine if management prescriptions are consistent across the planning horizon.

Recalling the fundamental concepts of harvest scheduling helps define unrealistic management in the latter part of the planning horizon: in a situation where the crop to be harvested often takes 50 to 100 years to mature, the purpose of a 100-year planning horizon is to estimate the long-term consequences of consistently applying near-term management trends over time, not to predict future events and how to react to them¹⁰. In the absence of forest control goals, a substantial change in management direction during the latter part of the planning horizon can artificially boost the LTSY estimate, thereby allowing higher immediate harvest levels.

Information Requirements and Review Guidelines:

In order to determine whether the LTSY estimate is a realistic projection of management patterns into the future, CDF needs the following information:

- a. Descriptions of all management prescriptions used in the harvest schedule, and
- b. A list of the acres assigned to each management prescription in each planning period.

All other factors constant, acres by prescriptions should be reasonably uniform throughout the planning horizon. However, the issue of consistent prescriptions must be separated from bona fide forest regulation issues. For example, in a forest with an initial structure that is different from what the landowner wants to achieve, changing management direction may be required throughout the planning interval in order to achieve a forest regulated to the landowner's goals at the planning horizon. As a general guideline for review, all substantial changes in management direction over the planning horizon should be linked to a well defined forest management goal in the harvest schedule.

3.2. CONSTRAINTS IMPOSED BY OTHER FOREST VALUES

¹⁰ This is illustrated by the fact that long term management plans covering a 100-year-plus planning horizon are routinely revised after only 5 or 10 years, as situations change.

14 CCR §§ 913.11(b)(2) [933.11(b)(2), 953.11(b)(2)] and 913.11(b)(3) [933.11(b)(3), 953.11(b)(3)] of the forest practice rules states that submitters must account for limits on productivity due to constraints imposed from consideration of other forest values, including but not limited to:

Soil, air,
Fish and wildlife,
Water resources,
Range and forage,
Employment and regional economic vitality, and
Recreation and aesthetic enjoyment.

In order to determine whether this requirement has been met, CDF needs sufficient information to ascertain whether limits on productivity are set by any of these other forest values. In order to evaluate whether the requirements of 14 CCR §§ 913.11(b)(2)-(3) [933.11(b)(2)-(3), 953.11(b)(2)-(3)] have been met, CDF also needs to determine if the submitters have accounted for constraints from other forest values in their estimate of LTSY. Other forest values are usually incorporated in harvest schedules by either restricting the timber land base, or the management prescriptions allowed. Either option has the potential to reduce the LTSY.

Information Requirement:

In order to meet the requirements of 14 CCR §§ 913.11(b)(2), (3) and (4) [933.11(b)(2), (3) and (4), 953.11(b)(2), (3) and (4)] the submitters must establish a link between the restrictions on timber production imposed by wildlife, watersheds, and other public trust resources and their analysis of timber growth and harvest:

- a. Identify the constraints imposed by these other forest values,
- b. Quantify them if relevant for their unique ownership, and
- c. Adjust the LTSY if any of the constraints do indeed affect timber productivity.

Steps a. - c. can be achieved by summarizing the acreage allocations and management prescriptions used to address each of the other forest values.

Review Guidelines:

The submitters should address each one of the other forest values listed in 14 CCR §§ 913.11(b)(2)-(3) [933.11(b)(2)-(3), 953.11(b)(2)-(3)], to the level of detail necessary for their unique ownership. For example, regional economic vitality and employment could consist of a brief description of anticipated effects. Wildlife constraints analyses in many cases could require addressing all the major species in the NTMP area that may be affected, using publicly available data such as the WHR database.

APPENDIX III

Inventory Stratification

Is it Necessary in Appraising Sustainability?

Key terms: forest, stand, silvicultural system, forest regulation, components of growth, stand dynamics, stratification key, minimal mapping standards, RPF efficiency.

Introduction

Recently, Registered Professional Foresters (RPFs) preparing Non-Industrial Management Plans (NTMPs) and CDF Review Teams have been engaged in debate centered over the necessity to stratify inventories as part of preparing a growth and yield sustainability assessment. NTMPs representing areas upwards of 2,500 acres have been submitted to CDF with many based on one average stand description intended to represent the range of vegetative conditions found across the plan area. This could include a spectrum from mature timber to hardwood-dominated to grassland that ultimately is planned for conifer reforestation. Other NTMPs have been based on a stratification key that typically produces strata counts of four to eight types. Some examples of considerable extent include a 650-acre plan having 14 types, and a 2,500-acre plan having 18 types.

Some foresters contend one tree list—that reflects the average stand structure for an ownership—is sufficient to address management targets and concepts of sustainability across the multitude of forest composition, structure and site productivity conditions that exist within an ownership. For discussion purposes the Department describes this as a *total ownership approach*. Typically, in this approach, growth and harvest projections span one to several decades and conclusions made about desirable goals and corresponding timelines to achieve these goals are based on unsupported representations.

Conversely, other foresters find themselves compelled to divide forests into stands or strata composed of similar characteristics in order to appraise age class distributions (both within a stand and across multiple stands), to appraise stocking levels, and to appraise the varied productivity levels typically found across sizable landscapes. From this level of detail they subsequently make growth and harvest projections in developing a harvest schedule based on landowner goals.

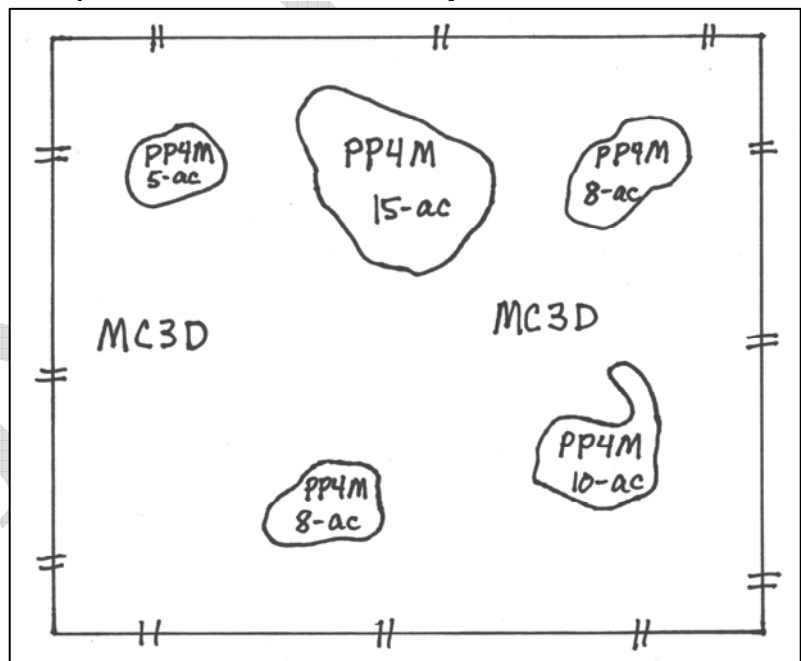
“Stand” versus “Management Unit”

In the practice of forestry the basic unit of resolution is a stand. Therefore, what considerations go into defining a stand? Is it equivalent to an ownership, or a previous harvest plan that may have encompassed broad areas such as an entire slope, or one or more drainages or all three, or is a stand something having a refined resolution more driven by ecological aspects perhaps in combination with these other elements?

Many RPFs have developed their own definitions of a stand that is inconsistent with professional standards and the Act and Rules. Figure 1 represents a common case found in NTMPs. In this example, two distinct vegetative types are present that are defined by species, tree size, and density. However, in many cases RPFs choose to group both types together into one stand. Reasons for this strategy vary, but include the stands being bounded by past THPs or present ownership boundaries, and the Forest Practice Rule's (Rules) lack of a minimum mapping standard for stand types. Others reasons relate to minimum mapping standards that the Rules define for Erosion Hazard Rating (EHR) or site class determination. EHR mapping standards are based on 20-acre minimums, whereas 10-acre standards apply to mapping of site class. Consequently, if a potential stratum represents an area less than the RPF's selected standard, the RPF concludes that it must be permissible to lump the individual stratum with the larger neighboring stratum; *otherwise, the Board of Forestry would have defined a separate standard.* Also, RPFs contest the necessity of stand stratification by referring to the standard error statistic of their timber inventory as being below 15% thus supporting their contention that it is not necessary to stratify.

Another more significant, related element is that other RPFs include disparate stands into one type based on geographical separation of individual polygons that comprise the distinct vegetative type. Again, referring to Figure 1; the PP4M stratum is made up of 5 individual polygons that are geographically separated, but collectively represent about one-fifth of the total area. This example holds true even if the PP4M stratum was represented by grass, brush, hardwoods, or recently established conifer plantations. Consequently, even a unique stratum that represents a significant proportion of the forest is ignored because of its dispersion across the landscape.

Figure 1. Representation of an ownership composed of two vegetative strata. Strata differences are explained by species composition, tree size, and density.



Finally, RPFs note the Rules do not specifically include a requirement to stratify an inventory into strata composed of like vegetation. Purely from an inventory standpoint, stratification is not necessary. However, the real question is whether it is necessary for the purpose of making management decisions and reliable projections of growth?

Regulatory Requirements and Guidance

The Rules provide no definition of a stand, however, authoritative forestry texts in mensuration, silviculture, and forest management offer similar definitions. These definitions are comparable to the one offered by the *Society of American Foresters* (SAF) which provides: a **stand**--as it relates to silviculture--is defined as “*a contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.*”¹¹

Although the Rules do not define stand, they do include a term that is predicated on stratifying a forest into distinctive vegetative types. Comparable with usage in forestry texts, the FPRs define **silvicultural system** as {emphasis added} “*the planned program of forest stand treatments during the life of a stand. It consists of a number of integrated steps conducted in logical sequence leading to or maintaining a forest stand of distinctive form for the level of management intensity desired*” (14 CCR § 895.1).

The Forest Practice Act and Forest Practice Rules Overlap

The Act and Rules overlap in several instances. PRC § 4593.3(f) states {emphasis added} “*a description of the existing stand, its current projected growth, alterations required to achieve the management objectives, the projected timber volumes and tree sizes to be available for harvest, and projected frequencies of harvest,*” and 14 CCR § 1090.5(g) states “*a description by management unit(s) of the timber stand characteristics including species composition, age classes, projected growth, present stocking level, present volume per acre, size class distribution, stand management history, and potential pest or protection problems.*”

Many RPFs have taken what appears to be inconsistent language to allow for the coalescing of multiple stands into one, but closer scrutiny in the clause “*a description by management unit(s) of the timber stand characteristics...*” should impart a clear distinction that the intent of this subsection is a stand level resolution.

Additional evidence supporting stratification can be gleaned from the Act. PRC § 4594.7 clearly requires that the Department must be able to determine if the objectives of the Act have been met. PRC § 4594.7, **cancellation of plan by department** provides the following:

If it is determined that the objectives of uneven aged management and sustained yield are not being met by a nonindustrial tree farmer, or there are other persistent violations detected that are not being corrected, a previously approved nonindustrial timber management plan shall be canceled by the department and any further timber operations under the plan shall be terminated.

¹¹ The Dictionary of Forestry. 1998. Society of American Foresters.

Finally, Article 7.5, subsection (c) provides that

...the Department shall, on or before January 1, 1998, report to the Governor and the Legislature with an evaluation on whether the objectives of unevenaged management and sustained yield are being met...

This reporting date was to follow within seven years of the enabling legislation, a period of time inconsistent with a *total ownership approach*, but completely consistent with a demonstration based on *stratification*. This logic demonstrates that the Board of Forestry and Fire Protection (Board) clearly intended that RPFs carry out their duties consistent with the standards and practices recognized in the profession.

Stratification is necessary because the Department must be able to verify the demonstration of MSP at any point in time over the course of implementation. Plans based on unsupported representations that can only be verified after a future re-inventory has been completed do not meet the test of *demonstration*. Secondly, once an NTMP is approved, Legislation removes governmental discretion to review harvest notices, allowing operations to commence immediately. For this reason, plans based on *stratification* permit the Department to evaluate during the plan review process and track in subsequent NTOs whether the proposed management complies with the Rules.

In summary, the Legislature and Board did not define every term previously recognized in professional forestry, nor did they lay out every procedure and protocol recognized as a standard and practice within respective disciplines of the profession. The Rules, in part were devised to ensure that forest management was conducted by licensed professionals sufficiently trained in the respective disciplines in order to carry out the intent of the Act and Rules. This is clear from language found in Registration of Professional Foresters Rules, PRC §1602(b), and in Professional Foresters Law, PRC §752(b).

Application of the Forest Practice Rules

Specific factors found in the Rules that RPFs should utilize when considering identifying stands are listed below. Forest Practice Rule requirements will be utilized by the Department in evaluating the information provided in an NTMP relative to growth and yield.

14 CCR § 913.2 (933.2, 953.2) Regeneration Methods Used in Unevenaged Management

Concepts about sustainability are based on properly assessing and managing existing age class distributions, and promoting development of new age class cohorts. Collated and averaged information that characterizes the *total ownership approach* does not allow for the proper assessment of variance within and between stands and likely will be inadequate for the Department to determine whether or not the proposed harvest activities conducted under an NTMP will be consistent with the stocking requirements of the rules.

14 CCR § 913.2 (933.2, 953.2) states”

Unevenaged management is utilized to establish and maintain an unevenaged stand structure. Unevenaged management attributes include the establishment and/or maintenance of a multi-aged, balanced stand structure, promotion of growth on leave trees throughout a broad range of diameter classes, and encouragement of natural reproduction.

Unevenaged stand structure, multi-aged, balanced stand structure, and promoting natural reproduction are concepts that are addressed at the stand level. Differences in species silvics and site productivity will control the post harvest growing stock density levels, regeneration, and rate of ingrowth and will influence the selection of a cutting cycle period. For example, to successfully establish a new age class and capture site productivity under an uneven-aged silvicultural system, overstory retention criteria for site I would be expected to be different than for site IV. Given this basic tenant, a reserve growing stock level of 160 ft²/acre of basal area prescribed for site class I is likely too high for site IV in promoting natural regeneration. Combining inventory data from multiple stands more often than not will not facilitate proper assessment of the management strategies and silvicultural application that are necessary at the stand level.

14 CCR §1090.5(g)

This code section requires information on “*species composition, age classes, present stocking levels, size class distributions, stand management history, potential pest or protection problems.*” In terms of making management decisions, each of these attributes is meaningful only when information is collected at the stand level. For example, in many environments hardwoods are a vigorous competitor on southerly aspects and can directly compete and suppress conifer growth. In the *total ownership approach*, such broad approaches that rely on stand averages from widely differing stand types would fail to disclose actual stand characteristics.

14 CCR §1090.5(i)

This rule requires information about “*projected frequencies of harvest,*” and “*silvicultural prescriptions for harvesting.*” Forests are typically composed of stands characterized by a unique structure, density, composition, and productivity rate. Accordingly, these stands may have their own unique silviculture prescriptions that translate into specific yield streams. Even though the plan preparing RPF may recognize many of the areas that he intends to harvest during the initial entry in a *total ownership approach*, absence to properly evaluate yield contributions from all stands makes the plan incomplete as it lacks a quantitative assessment of sustainability.

14 CCR §1090.5(j)

This code section specifies “[t]he period of time over which growth will be balanced with harvest.” The concept of *balancing growth with harvest over time* should communicate the same ideas as *sustainability, sustained yield, long-term sustained yield, and non-declining even flow.*

Davis and Johnson¹² describe “*three essential elements...required to manage and plan a forest in any coherent, quantitative way. Each element has a corresponding management decision that must be made at the outset of planning.*” These essential element” include the following:

- 1) A land-type classification scheme which is based on dividing a forest into homogeneous stands.
- 2) A management activity schedule describing the *timing, methods, and conditions by which the vegetation and other resources will be manipulated or disturbed to achieve desired outcomes*, including
 - i) Logging rules (e.g. marking prescriptions)
 - ii) A timber thinning and harvest schedule
 - iii) Regeneration techniques for the next tree crop
- 3) A quantitative growth and yield projection, which “*numerically describes how much timber is expected for commercial harvest; specifically, volumes removed at each thinning and final harvest entry for both the existing and subsequent regenerated stands.*”

The Rules do not explicitly speak to item (1), but much of the documentation in the Board’s *Silviculture Rule Making Files* include chapters excerpted from forestry text books. Much of the subject matter is based on the concept of “stands” or homogeneous vegetative units.

Item (2) is encompassed in the Rules for what are defined as *silvicultural methods* and *silvicultural system*. 14 CCR § 895.1 states that silvicultural methods is synonymous with silvicultural system, which is defined as “*the planned program of forest stand treatments during the life of a stand. It consists of a number of integrated steps conducted in logical sequence leading to or maintaining a forest stand of distinctive form for the level of management intensity desired.*”

Item (3) is addressed in various sections of the Act and Rules. 14 PRC § 4593.2 of the Act along with 14 CCR § 895.1 define sustained yield as “*the yield of commercial wood that an area of commercial timberland can produce continuously at a given intensity of management consistent with required environmental protection and which is professionally planned to achieve over time a balance between growth and removal.*”

A growth and yield projection is a forecast of desired sustainable harvest levels, which includes the intermediate or transitional treatments necessary to reach those desired harvest levels. If the initial quantitative growth and yield analysis projects that the balance between growth and harvest will occur in the fifth decade, but in time balance actually occurs in the fourth or even sixth decade, this fact does not invalidate the initial analysis. What must be recognized is that a forecast is simply that. The forecast is based on what is known today; this includes the defined management goals and accuracy levels of the growth model. Growth models such as FVS are constantly re-fitted as re-measurement data is obtained. From a projection standpoint, stochastic events such as wildfire or insect outbreaks are not normally addressed unless they occur in clearly predictable cycles.

¹² Davis, Lawrence S., K. and Norman Johnson, Forest Management, Boston: McGraw Hill, 1987.

Management Planning

The principal elements that go into a forest management plan are based on an understanding of the following:

- A **forest** is defined as {emphasis added} “*an ecosystem characterized by a more or less dense and extensive tree cover, often consisting of stands varying in characteristics such as species composition, structure, age class, and associated processes, and commonly including meadows, streams, fish, and wildlife.*”¹³ Concepts of forest management are based on dividing a landscape into areas having like characteristics. Contained within a forest management plan is a schedule of forest regulation.
- **Forest regulation** is defined as “*the technical aspects of controlling stocking, harvests, growth, and yields to meet management objectives including sustained yield.*”¹⁴ Various disciplines within forestry, such as mensuration, silviculture, growth and yield, harvest scheduling, financial appraisals, and forest products, coupled with environmental assessments such as based on California Wildlife Habitat Relationships, and rates of harvest within watersheds, all rely on proper application in stratifying a forest inventory for the purpose of making management decisions.

An assessment of sustainability includes three parts: (1) proper establishment of the baseline conditions, (2) identification of stocking levels that optimize the site for the given products desired, and (3) identification of the intermediate or transitional treatments that are necessary to reach desired stocking levels.

Making accurate growth and yield projections requires that a forest is divided into units composed of like characteristics. Models such as Forest Vegetation Simulator (formally known as *Prognosis*), and CRYPTOS are constructed based on tree and site data originating from **stands** that have unique characteristics. Key elements for any growth projection include consideration of the following factors:

- Individual Tree Growth and Silvics of the Species Present
- Stand Growth
- Stand Typing and Stratification
- Competition and Stand Differentiation
- Inventory Designs for Making Management Decisions

¹³ The Dictionary of Forestry. 1998. Society of American Foresters.

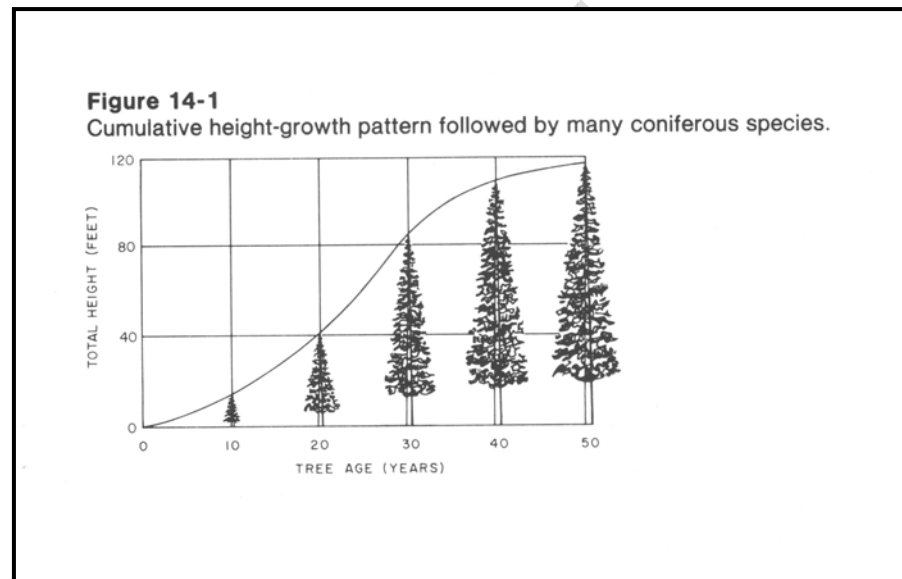
¹⁴ The Dictionary of Forestry. 1998. Society of American Foresters.

Individual Tree Growth and Silvics of the Species Present

Designing a harvest schedule is dependant on making accurate growth projections, which requires recognition of tree growth theory and components of stand growth. As illustrated in *Forest Measurements* (Avery and Burkhart, 1983), Figure 2 depicts the cumulative height growth pattern followed by many coniferous species. The shape of this curve (elongated S-shaped pattern) is described as *sigmoid*, and the significance is that most functions of tree growth such as diameter, basal area or cubic volume can be described by this pattern.¹⁵ The exact

form or amplitude along both the x- and y-axis of a cumulative growth curve will vary by independent variable used, therefore, measured growth rates, for example by diameters, cannot be extended to patterns in height growth and vice versa.

Figure 2. The cumulative height-growth pattern followed by many coniferous species. X-axis is total tree age; y-axis is total height in feet.

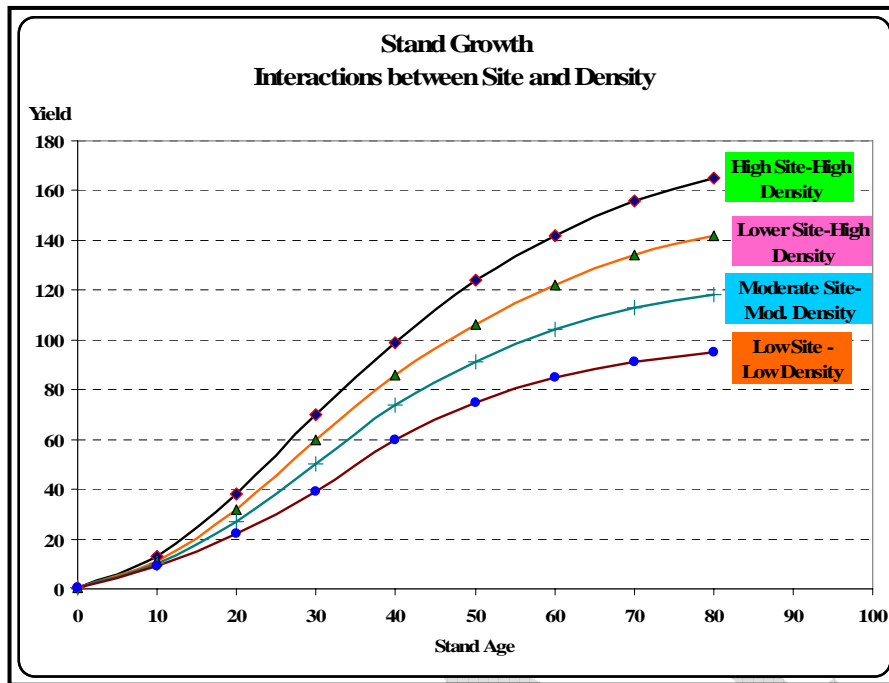


Stand Growth

The summation of each individual tree growth curve would produce similar sigmoid-shaped curve patterns to reflect stand growth. Figure 3 represents a simplified illustration of stand growth where differences are a function of density and site. Appreciably altering any one variable will result in a different yield trajectory. What is important to note in Figure 3, other than differences in yield, are productivity rates at specific points in time. For example, between the high-density curves at the 30 to 40 year period, the difference in productivity is roughly 12%, whereas the difference between the highest and lowest yield curves for the same period is about 28%. Once again, reliable growth projections are dependent on developing representative stand types, and stand typing is a crucial element of harvest scheduling.

¹⁵ Avery, Thomas Eugene, Harold E. Burkhart. *Forest Measurements*. Third ed. 1983. Chapter 14: Tree Growth and Stand-Table Projection; Predictions of Tree Growth, pg 261. McGraw-Hill, New York, N.Y. 331 p.

Figure 3. The interplay between site and density in total yield.



Growth and harvest projections from a **stand-table projection** worksheet, sampling to determine growth movement ratios are assumed to reflect competition and productivity levels that are expressed at the **stand** level. The rate of tree growth, whether measured in diameter, height, form, or volume is heavily dependent on relative age.¹⁶ Consequently, future projections of growth based on measures of past growth should be limited to short periods of time, typically not more than 10 years. Otherwise, large errors will result by assuming that future growth is equivalent to past growth. Avery and Burkhart (1983) provide a rule-of-thumb that growth predictions from diameter relationships are most reliable during the midlife of a tree when size increases can be characterized by the central (near linear) portion of the cumulative growth curve (see Figure 2, curve segment corresponding to year 20-30). Additionally, growth projections derived from increment borer samples can contribute erroneous estimates as patterns in radial growth can vary significantly based on the radii that is measured.

Stand Typing and Stratification

The purpose of stand typing¹⁷ is to divide a forest into units having similar characteristics for the purpose of devising silvicultural prescriptions that produce desirable products forever without depleting productive capacity of a site. A **prescription** is “a planned series of treatments designed to change current stand structure to one that meets management goals that normally

¹⁶ Avery, Thomas Eugene, Harold E. Burkhart. Forest Measurements. Third ed. 1983. Chapter 14: Tree Growth and Stand-Table Projection; Predictions of Tree Growth, pg 265. McGraw-Hill, New York, N.Y. 331 p.

¹⁷ **Stand type** is defined as “a class of stand defined for silviculture or management purposes, usually according to composition, structure, and age.” The Dictionary of Forestry. 1998. Society of American Foresters.

*considers ecological, economic, and societal constraints.”*¹⁸ In developing a stratification key, the decision criterion for sub-dividing a forest into smaller sub-units should include the components of growth, possibly differences in harvest systems, and differences in silviculture targets.

Important *components of growth* at the stand level include: (1) density, (2) site productivity, (3) age, and (4) species composition. Each component plays a significant roll in growth as the interplay of these components affects growth patterns. Consequently, it is important to understand and recognize these significant components, since the application of a specific growth and yield model {emphasis added} “*assumes a relatively homogeneous stand with regard to independent variables (e.g. age, site index, BA) used to predict stand values. If there is significant variation in variables such as site or stand density for a given area, the area must be stratified into reasonably homogeneous stands and predictions made separately for each of these stands to ensure accurate results.*”¹⁹

When assessing whether to differentiate two potential strata, the RPF may want to devise *site* and *area rules* (or thresholds) as part of the decision process in a stratification key. *Site rules* refer to relative differences in those stand variables that are being compared, such as differences in density. *Area rules* refer to the relative representation in terms of area or acreage between any two potential strata that are being appraised by *site rules* (e.g. basal area). For example, an ownership has been cruised and candidate stand “A” has an average basal area of 200 sq.ft./ac., with candidate stand “B” averaging 160 sq.ft./ac. Additionally, stand “A” represents 80% of the total timbered ownership, with stand “B” the remaining 20%. Consequently, the differences between *sites* and *areas* would likely result in significantly different silviculture prescriptions and thus corresponding yield stream contributions to the overall harvest schedule that likely exceed a level of significance to justify separate appraisals. Ultimately, the RPF is responsible for defining an appropriate stratification key that results in reliable projections of growth.

Successful stratification of most forests can be accomplished based on species composition, density, tree size, and site productivity. Sometimes tree size and site productivity are similar across a forest, thus reducing a stratification key down to two variables.

(1) Density

Stand density has a significant function on yield. A major consideration in appraising sustained yield is ascertaining optimum density levels that maximize productivity. A reasonable starting point for defining density thresholds is around 15 to 20%. Higher thresholds would likely correspond to significant differences between applied silvicultural prescriptions including density and diameter distribution targets that corresponding growth would likely exceed levels of significance and compromise the estimate of sustainability.

¹⁸ The Dictionary of Forestry. 1998. Society of American Foresters.

¹⁹ Avery, Thomas Eugene, Harold E. Burkhart. Forest Measurements. Third ed. 1983. Chapter 15: Growth and Yield Models, A Word of Caution, pg 303. McGraw-Hill, New York, N.Y. 331 p.

(2) Site Productivity

Site index²⁰ is the standard measure of site quality. Growth curves of site index represent the interaction between a specific species' population and its environment. Site index is typically applied as an independent variable in growth and yield forecasting. Krumland and Eng (2005) report {emphasis added}:

Experimentation with the CRYPTOS and CACTOS growth models (Wensel et al., 1987, 1986) indicates that altering site index input values by 10 percent results in differences in growth estimates of 2-15 percent depending on which stand attribute is being examined (basal area, cubic volume, board foot volume, stand density, age of development, species composition and a variety of other factors). As a rough rule of thumb, percentage differences in site index result in differences in growth predictions of a comparable magnitude.

The Rules define site productivity by five site class ranges. From a technical aspect, site class has the most profound impact on growth projections. Preferably, strata should be modeled by site class. For example, site class I should be modeled separately from site II, and so on. However, the Department's minimum expectation is that an MSP analysis should be based on site class groupings that follow the Rules' minimum stocking standards. These standards are based on three independent site class groupings: (1) site class I; (2) site class II and III; and (3) site class IV and V. The Department will consider deviations from this, such as combining a high site class IV ground with a low site III, provided that modeling and actual on-the-ground targets are not based on the minimum standards for a given site class, but have a higher retention standard.

(3) Age

Age is another important variable as it relates to an even-aged stand²¹ and an uneven-aged stand²². Age is important in designing a group selection prescription and in creating new age classes under single-tree selection.

As a substitute for age, differences in stand structure such as distributions of basal area or trees per acre by 2-inch DBH classes may be an acceptable way to describe a stand having more than one age class. Conceivably, the two stands in Figure 4 could have the same age, but differ by site productivity.

²⁰ Site index is defined as "a species-specific measure of actual or potential forest productivity expressed in terms of the average height of trees included in a specified stand component (defined as a certain number of dominants, codominants, or the largest and tallest trees per unit area) at a specified index or base age." From The Dictionary of Forestry. 1998. Society of American Foresters.

²¹ Even-aged stand is defined "a stand of trees composed of a single age class in which the range of tree ages is usually ± 20 percent of rotation." The Dictionary of Forestry. 1998. Society of American Foresters.

²² Uneven-aged stand is defined as "a stand with trees of three or more distinct age classes, either intimately mixed or in small groups." The Dictionary of Forestry. 1998. Society of American Foresters.

Age—Structure Relationships

Structure thresholds are a bit more problematic to define. Appreciable differences in structure that require different prescription targets should necessitate separate analysis. The two stands portrayed in Figure 4 have precisely the same BA but differ in diameter distributions, which could result in different growth trajectories and different prescriptions. In general if the area represented by the minor strata represents 10% or more of the total forest area, then the RPF should consider appraising each stratum separately.

A word of caution; avoid the temptation to assume that a bi- or multi-modal diameter distribution reflects a stand having more than one age class. Many second growth stands having originated from a single event may have two or more modes as a result of one or more harvest entries. Thus what appears to be a multi-age stand is actually made up of trees originating at the same time.

(4) Species Composition

Generally speaking, individual species found in a mixed species stand will have their own unique growth curves. Additionally, desired management objectives may favor growth and regeneration of certain species over others. An example includes an ownership where southerly aspects are composed of pine and Douglas-fir, with northerly aspects having white fir and Douglas-fir. The yield curves associated with each species will be sufficiently unique to require development of specific silvicultural systems.

RPFs should also recognize that the potential number of individual stand types that are generated based on a particular stratification key can be overwhelming. Stratifying highly variable landscapes can be a challenge to foresters. Standard typing keys may require modification or aggregation into larger analysis units or both in order to make the analysis manageable from a modeling and prescription writing perspective. Often this will involve combining stand types that are relatively similar. Considerations for combining stand types into larger strata are presented further in this document.

Competition and Stand Differentiation

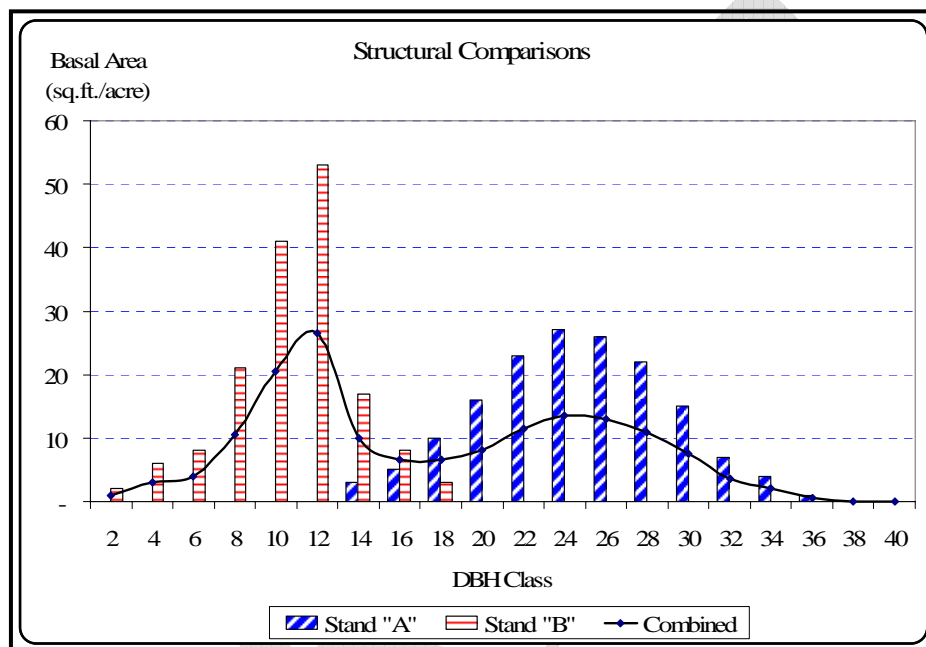
Stocking density, crown position, species, and genetics are all important elements that define competition within a species and between species at the stand level. As a result of competition, a stand will differentiate over time as differentiation of crown classes progresses. For these reasons, foresters should cautiously assess the correlation of tree size with age and not automatically assume that the smaller DBH classes found in a stand reflect younger age classes.

Inventory Designs for Making Management Decisions

Purely from an inventory standpoint, stratification is not necessary if the sole purpose is to determine total standing inventory. However, reliable growth projections are based on simulating prescriptions that emulate what will be implemented on the ground. Another analogy

can be explained using Figure 4, which describes diameter distributions for a stratified forest. Both stands, although having the same basal area (159 sq.ft./acre), are represented by contrasting diameter distributions, which are on different growth trajectories, and, as a result, should be managed differently. In this example, combining both stands to reflect one average stand for the ownership and subsequently making growth and harvest projections would produce unreliable results, which would likely not reflect the management prescription that will actually occur on-the-ground. Two scenarios are presented below which illustrate this point.

Figure 4. Diameter distributions for two discrete stands, and both combined.



Scenario #1:

Figure 4 portrays two discrete stands that represent a forest. Desired management is based on group selection where initial entries are commercial thinning stand “B” and those portions of stand “A” that are not regenerated by group selection. Both stands originated from a single event and are even-aged. The commercial thinning prescription calls for compressing the diameter distribution towards the dominant and co-dominant elements of each stand, harvesting most of the suppressed and intermediate elements, and spacing out the dominants and co-dominants. As for the over-lapping diameter distributions, most of the 14- to 18-inch DBH classes will be harvested in stand “A,” whereas a majority of this same distribution will be retained in stand “B.”

Using a growth model, whether an individual tree model like CRYPTOS, or a spread sheet type Stand Table Projection, it is impossible to aggregate data from multiple stands and site classes, make projections of growth and harvest under various silvicultural prescription and then disaggregate the single stand data back into their respective strata at the level of detail necessary to implement a marking prescription.

Scenario #2:

The “combined” curve in Figure 4 represents the average for both stands combined. This curve has a bi-modal distribution and on first appearance conveys a stand having two distinctive age classes. Although the plan preparing RPF may be able to associate each mode with actual on-the-ground location and envision the future for each stand, without substantial qualification this data conveys limited information useful to management planning. Any growth projections based on this data will not be reliable. Moreover, in a combined distribution, if single-tree selection is prescribed, a combined sample does not lend itself to addressing age class distributions and whether applied management practices will ameliorate or exacerbate potential gaps. A successful sustainability plan is based on appropriate management of existing age class distributions and creating new age classes.

Sampling Design and Intensity

The foundation of every statistical problem begins with concepts that define a *population*. Statistical texts define *population* as a set of data that characterizes some phenomenon. This phenomenon respective to evaluating for sustained yield is *growth*. The second element of a statistical problem is the *sample*, which is defined as a subset of data selected from a population. The third element of a statistical problem is the *inference*. A *statistical inference* is defined as an estimate or a prediction about a population based on information contained in a sample. The fourth and most important element of a statistical problem is a measure in the *reliability* of the inference.

Recognizing these elements of statistics, the primary purpose in stratifying a forest into like stands is to make inferences about growth that has associated with it a level of reliability (i.e. statistical significance). The Act and Rules do not define statistical standards for NTMPs, however, 14 CCR § 1091.4.5(c)(4) define standards for what is known as an Option “B,” Sustained Yield Plan common to industry. In summary, the Rules define standards in terms of **standard errors** that are no greater than 15% of their respective inventory estimates *for the major vegetative types* {emphasis added}. Please recognize that vegetative types is not defined in the Act or Rules, however, it is defined in authoritative forestry texts and dictionaries as synonymous with stand types.

In the Department’s review of inventory data presented in an NTMP, one of the key evaluation points from the Department’s perspective is how representative the sampling methodology is. Specifically, does the sample data reasonably reflect what is on the ground? Therefore, in order to ensure a high level of statistical validity associated with growth projections, the Department recommends a sample design and intensity that will produce reliable growth projections for the major strata found on a plan.

Combining Stand Types

Considering all of the variables and any vagaries that might be associated with an inventory stratification process and growth and harvest simulation, the potential number of stand types (i.e.

strata) that could be derived based on a selected standard could be unmanageable. When a project presents a large count in stand types, appraising for growth on each stratum could translate into an overly burdensome task that likely could compromise bringing the project to fruition. Consequently, gross stratification of the lesser represented populations may be prudent with proper justification that resulting projections of growth remain reasonable.

For projection purposes, combining different stand types into larger stratum is a reasonable strategy for approaching situations where the number of stand types is unwieldy from a growth projection standpoint. In general these situations typically occur due to limited area of a distinct stand type or types being represented on the NTMP to justify making a separate projection. Where this occurs it may be necessary and acceptable to combine the acreage with larger similar stand types. This situation can also occur when unmappable microsite conditions make delineation infeasible.

Under either of these situations, where it is necessary to combine strata that are similar by density, composition, and productivity, the RPF will need to develop a reasonable approach to modeling which reflects the aggregation strategies, describes the decision process and criteria that were utilized to create the strata, and include management guidance in the terms of prescriptions that provide clear direction relative to how stands will be marked and managed under the current and future harvests planned under the NTMP. The initial stratification key and associated mapping should also be maintained by the RPF for reference during implementation.

Defining an Appropriate Mapping Resolution for Sustainability Assessments

Defining a minimal mapping unit is a major consideration in developing a long-term management plan. Issues of stocking and productivity are critical elements in a sustainability assessment that should be addressed at more appropriate scales than what is defined for EHR or site class mapping standards. Sustainability is based on managing existing age class distributions, creating new age classes, and enhancing stocking levels that approaches an optimum level given carrying capacity of the site. In an uneven-aged system, successful natural regeneration is partly a function of seed dispersal from seed trees. Considerations for moving an ownership towards productivity levels that approach optimum levels should give weight to those elements that have the greatest bearing on realizing potential for each site.

Aids to Delineation--Cruise Plot Mapping

Another useful aid for evaluating strata differences is a cruise plot map. This is constructed along the lines of a planimetric map of the ownership or management unit²³ at a scale that allows inscription of each plot location and associated plot number, along with conifer and hardwood density measures in a numerator and denominator form off to the side of each plot. Figure 5 illustrates an example commonly used with aerial photography as an aid in delineating potential strata. In the absence of high resolution aerial photography (e.g. 1:15,840—4"/mile), additional field work will likely be required to accurately map strata boundaries.

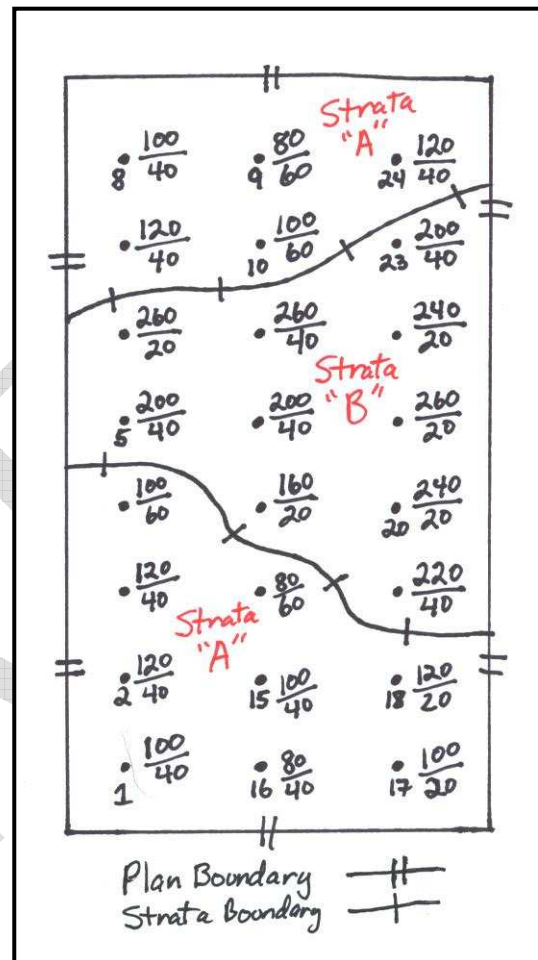
RPF Efficiency—Professional Responsibility—Scope of Project

RPFs should consider the scope and complexity of a project, which requires producing a harvest schedule that complies with the Rules, in relation to his or her technical skills. RPFs must recognize that the Rules do not allow the Department the prerogative to decrease the level of information and data requirements necessary to adequately demonstrate MSP due to an RPF's knowledge in the subject of growth and yield or lack of technical background to process data into a projection of MSP. In such cases, RPFs are obligated to associate with other professional specialists to ensure that their plans are based on recognized standards and practices, and are in compliance with all rules and regulations (see PRC §752(b) of Professional Foresters Law).

Conclusion

To a large extent, regulations addressing maximum sustained production and sustained yield reflect a performance based approach which reflects the landowner's management objectives with baseline stocking defined by the Forest Practice Rules. In many cases landowners may and have elected to exceed the minimum stocking standards to achieve a higher productivity level or

Figure 5. Example of a cruise plot map for strata delineation.



²³ Management unit: "A geographically contiguous parcel of land containing one or more stand types and usually defined by watershed, ownership, or administrative boundaries for purposes of locating and implementing prescriptions. A management unit is usually larger than a stand and typically contains many stand types and individual stands (synonyms: heterogeneous planning unit, allocation and scheduling zone, administrative area)." Davis, Lawrence S., K. Norman Johnson. 1987. Forest Management. 3rd Edition. McGraw-Hill Book Co. New York.

a variety of other management objectives. The rules allow the RPF to define performance standards with the expectation that RPFs rely on standards and practices recognized in each respective discipline of forestry. The subject of this paper addresses fundamental issues that RPFs should recognize as important building blocks to an NTMP. Ultimately, since an NTMP represents a permanent harvest permit, an NTMP must be sufficiently detailed so that subsequent RPFs that assume a plan in the future will be able to continue to implement it.

DRAFT

APPENDIX IV

CDF Policy Regarding Applicability of Intermediate Treatments In NTMPs That Demonstrate MSP by Option C

State of California

The Resources Agency

Memorandum

To: Region Chiefs
Assistant Region Chiefs
Unit Chiefs
Forest Practice Staff

Date: July 15, 2002

R30

Telephone: (707) 576-2275

Website: www.fire.ca.gov

From: Dean Lucke
Assistant Deputy Director, Forest Practice
Department of Forestry and Fire Protection

Subject: Revision of CDF policy regarding the applicability of intermediate treatments for NTMPs that demonstrate MSP by Option C [(14 CCR 913.11-, 933.11-, 953.11-(c)].

On February 1, 2002, CDF defined policy as it relates to the use of intermediate treatments in a NTMP that proposes the demonstration of MSP under an Option C. This memorandum defines modification to this policy after receiving rule interpretation from the Board of Forestry and Fire Protection's Interim Committee during the June 2002 meeting.

Summary of February Policy Memorandum

The Forest Practice Rules (FPR) provide two standards for a NTMP to demonstrate MSP. CDF's February memorandum defining policy was the result of interpreting code section that distinguishes an Option B from an Option C for demonstrating MSP. CDF's interpretation was that since the legislature mandated uneven-aged management for NTMPs, an Option C MSP standard is achieved by complying with code section CCR 913.11(c)(2) which is as follows:

For unevenaged management, complying with the seed tree retention standards pursuant to 913.1 (c)(1)(A),...

Thus, compliance under the Option C MSP standard is achieved when the prescription retains at least eight 18-inch DBH, or four 24-inch DBH, or combination thereof, in seed trees from the onset of any prescription implementation. Alternatively, if a proposed NTMP included a silviculture prescription of an intermediate treatment that could not meet the seed tree retention standards of 913.11(c)(1)(A), the submitter was then restricted to demonstrating MSP for the

NTMP under an Option B standard. By this, CDF concluded that a NTMP had to demonstrate MSP entirely by only one standard, either Option B or C, as the NTMP could not be partitioned into two MSP standards.

The original policy directive was the result of CDF having concerns that previously approved plans had continued to invoke intermediate treatments that appeared to be absent of a commitment to transition to uneven-aged management and the establishment in new age classes. Additionally, CDF had observed an increase in submitted plans proposing to commence with an intermediate treatment without defining a definite schedule in converting to uneven-aged management.

Policy Revision

CDF subsequently presented this policy to the Board's Interim Committee during the June 2002 meeting. As a result of discussions with the Interim Committee, CDF has revised the policy to reflect the following:

NTMPs submitted under an Option C demonstration of MSP can propose intermediate treatments and meet MSP under 913.11 [933.11 & 953.11] (c)(3) which specifies the following:

For intermediate treatments and special prescriptions, complying with the stocking requirements of the individual treatment or prescription.

However, when the silviculture prescription cannot meet the seed tree retention standards [913.1 (c)(1)(A)], the submitter must comply with provisions detailed below to establish a convincing case to the Director that the objective of uneven-aged management is attainable within the specified timeline.

For a stand proposed for harvest that cannot comply with the seed tree retention standards [913.1 (c)(1)(A)], the NTMP must include a growth and yield analysis sufficiently detailed by pre- and post-harvest stand measures to allow assessment of the trajectory in stand development, to that point in time that the stand can be managed to comply with the seed tree retention standards. To establish a convincing case the following must be provided with the submittal of the NTMP:

- (1) For each stand type¹, a stand table of the existing condition in per-acre basis;
- (2) For each stand type, pre- and post-harvest stand tables for each growth and harvest period to that point in time that the stand can be managed to comply with the seed tree retention standards;
- (3) For each stand type, beginning gross and net inventory in Scribner board feet (per acre basis), along with existing basal area, and the projected pre- and post-harvest basal area for each period demonstrated in item #2 above.
- (4) Any stand that conceivably receive "staged harvesting"² shall provide discussion of the techniques that the RPF will utilize to ensure that each staged harvest does not over-

¹ A **stand type** as it relates to silviculture is defined as "a contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit." The Dictionary of Forestry, 1998. Society of American Foresters.

harvest inventory that is required to ensure that the subsequent growth culminates in the stand characteristics projected at the end of the cutting cycle; Otherwise CDF will interpret that the stand will be entered only once in each cutting cycle.

Data Presentation

For each stand type identified in items 1 and 2 above, data format shall consist of a single stand table for each stand type. This table shall encompass each Group A species by 2-inch diameter class in per-acre basis, and without coalescing species into groups. Group B species may be lumped under one column if there is no reason to appraise a certain specie representation separately.

Acceptable Models for Demonstration

Acceptable models for demonstrating this requirement are CACTOS, CRYPTOS, FVS, or stand table projection.

Re-evaluations

At the end of each cutting cycle until the point in time that the stand can be managed to comply with the seed tree retention standards, the RPF shall conduct a cruise to ascertain actual conditions with that projected, and provide a report of the analysis to CDF. The cruise shall follow conventional forestry standards and cruise plots shall be sufficiently monumented on the ground so that CDF can have the opportunity to retrace the layout in evaluating the adequacy of the cruise. Negative departures of 20% or more in actual seed trees from that projected will trigger an evaluation by CDF as to the commitment of the submitter to comply with the intent of the NTMP program.

Effective Date of Policy Revision and Allowance for Variances

This policy shall become effective immediately. However, for plans currently in review or submitted by January 1, 2003, a variance may be requested by the submitter if the detailed data cannot feasibly be obtained for those periods (i.e. cutting cycles) necessary to demonstrate when compliance with the seed tree standards will be met. In no circumstance will a variance be granted for projection of stand development in the first period. Any variance that is granted will be conditioned on the submitter providing the remaining information prior to the start of any harvests activity in the subsequent period.

Conclusion

NTMPs submitted under an Option C demonstration of MSP can propose intermediate treatments and meet MSP under 913.11 [933.11 & 953.11] (c)(3), which specifies “*For intermediate treatments and special prescriptions, complying with the stocking requirements of the individual treatment or prescription,*” provided that the submitter conducts an advanced quantitative analysis having data resolution levels and timelines as discussed above.

² Many plans present a reasonable argument that due to market fluctuation, harvesting may be staged in that any particular acre may be entered several times over the cutting cycle. For example, a stand managed on a 10-year cutting cycle may have its first entry in year three to harvest pine, then a return in year five for Douglas-fir, and completing the period by harvesting cedar in year eight.